

REMARKS/ARGUMENTS

Claims 12-19 are pending. Claims 1-11 have been cancelled without prejudice.

Support for the amendment can be found in the original claims and the specification (e.g., pages 7-8, 10-14; figures), as originally filed.

Applicants thank the Examiner for the discussion held on April 30, 2007. Applicants notified the Examiner that claims 1-11, not claims 1-10, were pending. The Examiner suggested filing a response to the Official Action because the claims are substantially similar. The Examiner further clarified the indefiniteness rejection.

Applicants have submitted a new abstract comprising one paragraph in response to the Examiner's objection.

Claims 1-3 and 6-10 are rejected as being indefinite. Applicants have amended the claims to recite that the pH of a treated liquid produced during the biological treatment process is adjusted. Applicants request that the rejection be withdrawn.

Claims 4-5 are canceled. Applicants request that the rejection of the claims be withdrawn.

Claims 1-2, 6, and 8 are rejected under 35 U.S.C. 102(b) as being anticipated either by JP 2000-61274 or JP 8-155485.

The Examiner has not indicated what limitations of the claimed invention are disclosed in the prior art references and where the limitations can be found.

Applicants have submitted EP 0970922 claiming priority to JP 231056/98 (JP 2000-61274A), which is an English equivalent of JP 2000-61274A, for the Examiner's consideration. Applicants have also submitted an English translation of JP 8-155485.

Applicants submit that neither JP 2000-61274 nor JP 8-155485 discloses “adding the recovered magnesium ammonium phosphate particles to an acid fermentation tank.”

JP 2000-61274 (EP0970922) describes a method for methane fermentation of organic waste and does not disclose recovering magnesium ammonium phosphate (“MAP”) particles from the treatment process and, not to mention, recycling the particles in a subsequent biological treatment process.

JP 8-155485 describes an anaerobic method for treating waste water. The MAP particles are obtained in tank 2 (fig. 1) and are not recycled to acid production tank 1. Only treated water from UASB tank 3 is partially supplied to tank 1 for adjusting the pH. The MAP particles do not float upward in UASB tank 3 and do not float out of UASB reaction tank 3 [0026]. Thus, JP 8-155485 does not disclose recycling the MAP particles in a subsequent biological treatment process.

Applicants request that the rejection be withdrawn.

A Notice of Allowance for all pending claims is requested.

Respectfully submitted,

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English translation of JP-A H08-155485

Publication date: June 18, 1996

Application No. H06-300737

Application date: December 5, 1994

Title: Anaerobic Treatment Method

[Claims]

An anaerobic treatment method comprising treating an organic waste water including nitrogen and phosphorus and then treating it in a USAB type methane production tank, the method being characterized in that magnesium salt is added into an acid production tank or its effluent while stirring to adjust a pH to a range from 7 to 9, the resulting treated effluent flowing into the USAB type methane production tank.

[0008] The present invention solves the above described conventional problems and has its object the provision of an anaerobic treatment method for simultaneously removing organic substances, nitrogen and phosphorus by the upflow anaerobic sludge blanket process (UASBP) and preventing sludge granules from floating and flowing out by depositing magnesium ammonium phosphate (MAP) without causing scaling.

[0012] In the method as shown in Fig. 1, a raw water such as *shochu* waste liquor, whisky distillation waste liquor and beer charge waste water is first introduced into an acid production tank 1 through piping 11 and sugar, protein and the like present in the raw water is decomposed into volatile lower fatty acids such as lactic acid, propionic acid, butyric acid and acetic acid. Specifically, in the acid production tank 1, acid production bacteria are present in a floating state or in a carrier-immobilized state so that a decomposition reaction occurs in lower fatty acids.

[0013] In this example, part of the treated water in the latter stage of the UASB reaction tank 3 is circulated to this acid production tank 1 through piping 12 equipped with a pump P<sub>1</sub> and simultaneously a magnesium (Mg) salt is added through

piping 13.

[0014] Thus, by circulating part of the treated water in the UASB reaction tank 3, a remarkable lowering of pH by acid production in the acid production tank 1 is prevented from causing an increase in acid production rate, and in the latter stage of the MAP production vessel 2, an amount of an alkali added for adjusting the pH can be reduced.

[0015] In this acid production tank 1, the pH varies depending on an amount of circulated water of the treated water, a concentration of the raw water and the like, but is normally 4 to 7, preferably in a weakly acidic state of 4.8 to 6.5 and MAP does not deposit in the tank. If necessary or required, it is also possible to add an alkali to the acid production tank 1 to increase the acid production rate, but the pH should definitely preferably be maintained within the above described range.

[0016] As the Mg salt which is added to the acid production tank 1, magnesium hydroxide  $[Mg(OH)_2]$ , magnesium oxide (MgO), magnesium chloride ( $MgCl_2$ ), magnesium sulfate ( $MgSO_4$ ) and the like can be used. Of them,  $Mg(OH)_2$  which is effective for pH adjustment as an alkali agent as well may be used, and when the pH within the system is more than 6.5, an acidic salt such as  $MgCl_2$  is added.

[0017] The ratio of the Mg salt added is set as at least one mole of the phosphorus to be removed, in other words, is preferably set at 1.1 to 1.5 times the mole of the phosphorus present in the raw water.

[0018] The effluent of the acid production tank 1 is next sent to an MAP production tank 2 through piping 14 and agitated in the tank. The agitation may be mechanical but is preferably that effected by aerating air or nitrogen through an aeration pipe 15. Further, by performing such aeration, dissolved carbon dioxide gas can be removed.

[0019] If necessary or required, an alkali such as sodium hydroxide (NaOH) is added to this MAP production tank 2 through piping 16 to adjust the pH to the range of 7 to 9, preferably 8 to 8.5. By adjusting the pH of this MAP production tank 2

to the range of 7 to 9, preferably 8 to 8.5,  $\text{PO}_4$ , -P,  $\text{NH}_4$ , -N and  $\text{Mg}^{2+}$  in the system within the MAP production tank 2 are reacted to deposit fine particles of MAP.

[0020] When this pH adjustment is performed at less than 7, the deposition efficiency of MAP is inferior and when the pH is more than 9, the methane production efficiency in the latter stage of the UASB reaction tank 3 is decreased.

[0021] By the pH adjustment and the agitation in the MAP production tank 2, MAP particles are efficiently deposited without causing scaling. Particularly by stripping the dissolved carbon dioxide gas by aeration, the pH in the system rises and thereby enables an amount of an alkali required to be added for the pH adjustment to be reduced. Furthermore, an excess rise in pH in the latter stage of the UASB reaction tank 3 can be prevented.

[0022] As the alkali which is added to the MAP production tank 2, NaOH and, in addition, calcium hydroxide  $[\text{Ca}(\text{OH})_2]$  and the like can be used. The addition of  $\text{Mg}(\text{OH})_2$  can simultaneously perform the pH adjustment and the Mg salt addition. Specifically, in this case, the Mg salt may be added not in the acid production tank 1 but in the MAP production tank 2.

[0023] In the MAP production tank 2, MAP particles having a particle diameter of several tens of microns to about 0.3 mm are produced by the agitation by aeration and the pH adjustment. The residence time in the MAP reaction tank 2 for producing such MAP particles is sufficient at from around 10 to around 60 minutes. Further, it is preferred that an amount of aeration in the MAP reaction tank 2 is set at about 3 to 10  $\text{Nm}^3/\text{m}^3/\text{Hr}$ .

[0024] The effluent of the MAP production tank 2 is next sent to a UASB reaction tank 3 through piping 17 equipped with a pump  $\text{P}_2$ . In the UASB reaction tank 3, an anaerobic biomembrane is formed on the surface of the inflow MAP particle, and by the growth of the biomembrane, a sludge granule grows to advance smooth methane production reaction from organic acids. In other words, the MAP particle functions as a nucleus of the sludge granule in this invention.

[0025] Thus, organic substances are decomposed by methane

production reaction and phosphorus and nitrogen in raw water are immobilized as MAP in the sludge granules within the UASB reactor 3, and part of the treated water from which organic substances, phosphorus and nitrogen have been removed is circulated to the acid production tank 1 through the piping 12, with the remainder being discharged outside the system through piping 18.

[0026] Further, the produced MAP-containing sludge granules increase settling properties by increasing the specific gravity due to the MAP deposition and are prevented from floating upwards in the UASB reaction tank 3 and flowing out of the UASB reaction tank 3. Excess sludge is withdrawn through piping 19.

[0032]

[Effect] In this invention, in the former stage of the UASB reaction tank, Mg salt is added and pH adjustment is performed to deposit MAP particles. In depositing these MAP particles, an amount of an alkali to be added to adjust a pH can be reduced by removing the dissolved carbon dioxide gas. Further, the agitation action by stripping in removing this carbon dioxide gas enables efficient deposition of MAP particles without causing scaling. In addition, a lowering of the methane production efficiency due to an excess rise in pH in the latter stage of the UASB reaction can be prevented. Incidentally, when pH adjustment is carried out with an alkali alone without performing stripping, the pH rises when organic acids are decomposed into methane in the latter stage of the UASB reaction tank, and may sometimes exceed the upper pH limit of 8.5, which limit is suitable for methane production bacteria; and thus it becomes necessary to lower the pH with an acid.

[0033] When the water in which MAP particles have been deposited flows into the UASB reaction tank, sludge granules grow using these MAP particles as nuclei in the UASB reaction tank. Since these MAP particles are continuously supplied into the UASB reaction tank, sludge granules are stably increased and not only N and P are removed by incorporating MAP into sludge

granules but also the effect of improving methane production efficiency is brought about.

[0034] Furthermore, the sludge granules enhance the settling properties by incorporating MAP therein to increase the gravity are effectively prevented from flowing upwards in the UASB reaction tank and flowing out of the UASB reaction tank.